THE DEPARTMENT OF CONSERVATION

STATE OF MICHIGAN

Geological Survey Division

•

Reprint from
TWENTY-SECOND BIENNIAL REPORT
1963-1964

1

GEOLOGICAL SURVEY DIVISION

GERALD E. EDDY, *State Geologist*

The Geological Survey supplied more industries, agencies, and individuals with assistance and guidance concerning the State's mineral resources during this biennium than at any time in history. More than 3,602 visitors were served at the Lansing office. About 80 percent were concerned with oil and gas; a result of widespread interest following discovery of the fabulous Albion-Scipio-Pulaski field in Hillsdale, Calhoun and Jackson counties and the prolific Niagaran Reef gas fields in St. Clair County.

Of special concern to this Section is the effect of population growth upon water resources. The principle responsibility of the Geological Survey in this is to inventory both surface and ground water through establishment of additional gauging stations and observation wells. This was done to only a small degree because of budgetary limitations. The Section cooperated with the U. S. Geological Survey in the program and in studies for special areas such as counties and municipalities.

Michigan's history of the oil and gas industry is similar to that of most oil producing states. That is, one of "feast or famine." During the last two years, with the exception of the reef oil and gas fields in St. Clair County, there have been few significant discoveries of new fields with a resulting decline in daily production of oil.

The 1963 value of all minerals produced was $485,580,000, exceeding the 1962 value by $47,900,000 and exceeding that of 1961 by $42,320,000.

Economic and competitive factors which caused a decline in underground high grade iron ore mining continued with additional mines closing. It appears that only the mines with ore bodies capable of being mined by low-cost methods, or those having an exceptionally high grade ore can remain competitive with high-grade foreign sources and with beneficiated ores from within and without the State.

The future of iron ore mining in Michigan lies in the beneficiation of low grade ores. Department geologists estimate there are one billion, eight hundred million tons of iron formation in the first 100 feet of depth which can be concentrated into 725,000,000 tons of high grade ore acceptable to the furnaces.

GENERAL GEOLOGY

This unit is the technical information center of the Survey, and a clearing house for general information in the field of earth sciences. Other functions include: review of technical literature, maintaining archives and publications exchanges, conducting lectures and field tours, preparing and distributing publications and maps, and coordinating research activities.

The following statistics provide a measure of some of the routine tasks performed by this unit: 1) 737 letters prepared, 2) more than 900 publications requests processed, and 3) talks given to a total audience of about 1,000 persons (size of groups averaged about 45 persons). Most of these were in connection with the Department's Conservation School at Higgins Lake, the National Science Foundation, the Michigan Education Association, and university extension organizations.

Publications prepared and issued were: 1) Michigan's Sand Dunes—a geologic sketch, 2) Michigan Geological Sourcebook, 3) Geological Map Index of Michigan, 1843-1962, 4) Price List of Available Publications of the Michigan Geological Survey, 1964, 5) Our Rock Riches, (manuscript submitted to printer at the end of biennium), and 6) progress manuscript map of Michigan Sand Dunes. Articles appearing in "Michigan Conservation" included "The Dunes," and "Michigan Beach Stones." In addition, art work was done for ten pieces other than geology.

Work also continued, or began, on technical or special projects: 1) Michigan peat resources map, 2) contouring bottoms of Lake Michigan and Lake Superior, 3) bibliography of Michigan geology, 4) 1:250,000 quadrangle mapping program, 5) automating both bibliographic procedures and publications distribution, 6) survey of elementary earth science courses at Michigan colleges, 7) re-classification of Survey publications, 8) contributions to the Geologic Names Committee, 9) Great Lakes shore lines measurements, 10) prospectus and specifications for a state geologic map program, 11) survey of cooperative topographic mapping program in Michigan, 12) report on Survey mapping functions and map services, 13) assistance in preparation of brief notes on geologic history of State, 14) planning 1964 Survey in-service training session, and 15) chart on organization and functions of the Survey.

The staff of the General Geology unit consisted of two geologists, an illustrator-draftsman, and a stenographer (shared with the Mining Section).

GEOLOGICAL SURVEY PUBLICATIONS

GENERAL GEOLOGY

Michigan's Sand Dunes—A Geologic Sketch
Michigan Geological Sourcebook, Circular 1
Michigan Beach Stones
Rocks and Minerals of Michigan, Publication 42, 1962 Revision

GEOPHYSICS

Regional Gravity and Magnetic Anomaly Maps of Southern Peninsula, Report of Investigation 1

INDEX

Geologic Map Index of Michigan, 1843-1962

MINERAL RESOURCES

Michigan Mineral Industries, 1961
Michigan Mineral Industries, 1962

OIL AND GAS

Information on Michigan Silurian Oil and Gas Pools
Summary of Operations, Oil and Gas Fields, 1962
Michigan's Oil and Gas Fields, 1963

PRICE LISTS

Available Publications of the Michigan Geological Survey, 1964.

In cooperation with the U.S. Geological Survey:

U.S.G.S. Water-Supply Paper 1619-E, Ground-Water Resources of the Alma-Area, Michigan, 1963
U.S.G.S. Surface Water Records of Michigan, 1962
U.S.G.S. Surface Water Records of Michigan, 1963
Progress Report 25, Summary of the Ground Water Conditions in the Elsie Area, Michigan
Water Investigation 1, Reconnaissance of the Ground Water Resources of Alger County, Michigan.

OPEN FILE MAPS

Aeromagnetic Map of Central Gogebic County, Michigan and Vicinity
Geologic Maps of the Marquette and Sands Quadrangles, Michigan
Geologic Map Showing Outcrop of the Nonesuch Shale from Calumet to Black River, Michigan

OIL AND GAS

There was a small but significant downward trend in this activity which resulted in the drilling and completion of less wells and the production of less barrels of oil. There were 255 oil wells completed compared with 461 oil wells during the previous biennium. Similarly, 32,243,422 barrels of oil were produced compared with 36,492,399 barrels during the previous biennium. Development of production in the Trenton-Black River Formation in the Albion-Scipio Trend Field, and the Salina-Niagaran reef production of St. Clair and Macomb counties brought drilling and production to a peak during the 1960-62 biennium. Because of a minimum of new discoveries of oil during the 1962-64 biennium, this high level of drilling and oil production were not maintained.

A significant factor in the oil and gas activity was the further development of production in the older and deeper formations of Michigan. The Salina-Niagaran and Trenton-Black River Formations contributed a major portion of the oil and gas produced during this period. Since the entire State is underlain by these formations, there is excellent potential for future oil and gas activity in Michigan.

Oil and Gas Activity

	July 1, 1960 June 30, 1962	July 1, 1962 June 30, 1964
Permits to drill	1,671	1,379
Well completions	1,624	1,323
Oil wells	461	255
Gas wells	99	122
Geological test permits	1	0
Gas storage wells	118	149
LPG storage wells	7	2
Exploratory wells	586	499
Oil discoveries	19	20
Gas discoveries	12	14
Oil production	36,492,399 bbls.	32,243,422 bbls.
Gas production	49,831,654 MCF	60,749,835 MCF
Producible oil wells	4,640	4,579
Producible gas wells	316	413
Cumulative oil production	469,256,467 bbls.	477,084,478 bbls.
Cumulative gas production	398,907,879 MCF	414,128,996 MCF
Producing oil fields	183	179
Producing gas fields	78	82

A review of the above data indicates interesting and encouraging trends. The number of gas wells completed was 122 during this biennium compared with 99 in the previous period. This also reflects an increase in gas production from 49,831,654,000 cubic feet to 60,749,835,000 cubic feet during the biennium just closed. The number of producible gas wells increased from 316 to 413. Another significant trend is the increase in gas storage activity. There were 149 gas storage wells completed as compared with 118 for the previous biennium.

The oil and gas industry in Michigan has compiled an enviable record for satisfactory disposal of oil field brines into approved underground formations. This disposal of brine has reduced to a minimum the possibility of pollution and damage which can result from improper handling of the brine. During 1963 the industry produced 149,696 barrels of oil field brine per day. There were 15 oil fields which produced in excess of 2,000 barrels of brine per day. Over 98 per cent of the total brine produced was returned to approved subsurface formations. The balance is returned to surface pits or used in the maintenance of lease and county roads.

The Geological Survey participated in 33 general hearings before the Supervisor of Wells and the Advisory Board to consider oil and gas matters. These hearings resulted in adoption of 19 spacing orders, amendment of 18 spacing orders, abrogation of six spacing orders, adoption of seven proration orders, amendment of four proration orders, abrogation of four proration orders, six hearings on unitization of a field or portion thereof, 12 hearings on pooling of properties, revision of the General Regulations on oil and gas, one

appeal to the Conservation Commission and one emergency order of the Supervisor of Wells.

There were 11 oil fields under proration at the end of the biennium. These fields produce approximately 28,000 barrels of crude oil per day or 65 percent of Michigan's total daily production of 43,000 barrels. Daily per well allowables for these prorated fields range from 50 to 150 barrels. The 605 oil producers currently under proration produce an average of 46 barrels per day.

Twelve scrubber-booster plants are in operation in Michigan oil fields. These processed 45.2 billion cubic feet of casinghead or oil well gas during the biennium from which were extracted 85,172,637 gallons (2,072,919 oil barrels) of liquid petroleum gases. In addition, 11.7 billion cubic feet from the Belle River Mills Field in St. Clair County were processed from which 15,760,672 gallons of liquid petroleum gases were extracted. One large plant in Southern Michigan handled 54 billion cubic feet of imported gas from which 8,352,690 gallons of liquids were stripped. The liquid extractions are also utilized by the fuel and chemical markets of Michigan.

There are twelve active oil refineries in Michigan with a total run capacity of 178,700 barrels. Actual runs average approximately 140,000 barrels per day of which 30 percent is Michigan-produced oil. The balance is imported oil made up of 85-87 percent domestic crude from other oil producing states and 13-15 percent Canadian crude.

PETROLEUM GEOLOGY

The Petroleum Unit has several functions which are interrelated. First, it aids in collecting and processing all available geological and engineering information relative to the drilling and completing of oil and gas tests in Michigan. Second, it makes this information available to all interested parties in the form of published logs, reports, maps, and as a sample library for sample studies. Third, it acts as a consulting and research agency on regulatory matters. Industry personnel, the general public, universities, and other state and federal agencies consult with the unit on all types of geological problems.

Although fewer new logs were received, they were on the average more detailed. Consequently more time was needed for processing. Most logs sold by special order were reproduced by xerox methods from microfilm. This process has created some hardships in that much of the film does not print legibly. It was necessary to refilm many of the logs. In addition to the microfilming, data from the logs is being transferred to IBM cards. Here again, progress is slow because of the technical nature of the data and the lack of trained personnel.

The sample library again played an important part in the activities. Although the Survey is unable to maintain a large sample and core depository because of space and budget problems, efforts are made to obtain samples on all exploratory wells with particular emphasis on deeper formational tests. Where possible, partial sets of samples have been placed in the universities in the State. These samples, in conjunction with mechanical logs, are of great value to the petroleum geologist in the exploration for oil and gas. A publication of available sample sets is in preparation.

The mechanical log library has grown substantially during the past two years. The library consists of several types of well logs. The more notable are gamma ray-neutron laterolog, density, and cement bond logs. These logs are used by Survey personnel in correlation and engineering studies for hearings and research programs.

A general tabulation of service programs for the period in question are tabulated below:

INVENTORY OF SERVICE PROGRAMS

Maps and Logs

Oil and Gas Well Logs

New logs received	1,404
Deepenings & reworks renewed	416
New logs published	1,089
Total logs available	3,100*
Logs sold by subscription	46,803
Logs sold by special order	36,000*

Oil, Gas, and Miscellaneous Maps

New maps available	10
Regular maps available	243
Miscellaneous maps available	57
Total available	300
Number sold	3,186

Topographic Maps

Inventory 7-1-62	4,718
Inventory 7-20-64	6,493
Number copies sold	10,769

Revenues Received

Revenue from logs	9,200*
Revenue from oil and gas maps	2,728.19
Revenue from topographic maps	3,268.50
	$15,196.49*

*Estimate

Sample Library

Number of Well Samples

Number of sets received	384
Total available	7,300

Inventory of Sample Sets Loaned

Oil & gas companies	700
Consultants	40
Universities, etc.	165
Total	905

Mechanical Log Library

Number of mechanical logs received	807
Number of wells with log coverage	2,832

In addition to the service functions, professional papers were published for the American Association of Petroleum Geologists and the Michigan's Manufacturers Magazine. Members contributed to the Michigan Story, a publication by the Michigan's Landman's Association. A very active role was played by members in the Professional Societies. Some progress was made on the interstate geological mapping program being conducted jointly by Indiana and Michigan. Members served on various committees of federal, state and private institutions. These included the Atomic Waste Disposal and Electronic Data Processing committees.

More than 2500 visitors received consultation on geological problems. Consultation and research on oil, gas, and water matters were carried on with other sections of the Department, Corporations and Securities Commission, Water Resources Commission, and the Highway Department.

MINES AND MINING

The annual valuation of iron and copper mines and metallic mineral lands for general property tax purposes continued to be a principal function of this unit. This is a

statutory duty of the State Geologist or his authorized deputy. The work requires the review and study of drill hole records, mine maps and cross-sections in the determination of ore reserves, as well as the examination of the surface and underground workings of the properties of the mining companies. These data, considered in conjunction with the economics of the individual mines and of the iron and copper mining industries, are used in determining valuations.

Prior to 1964 these valuations were certified to the local assessors for entry on the tax rolls, but Act 66, P.A. 1963, provides that henceforth the valuations shall be reported to the State Tax Commission. That agency then assesses the mineral properties in conformity and uniformity with other property in the assessing district.

Almost 100 mining properties, about one-half of which were parts of active mining operations, were valued during each of the years of the biennium. Valuations for iron ore properties totaled $55,230,000 for 1963 and $48,114,000 for 1964. Copper properties were valued at $14,546,000 in 1963 and $15,297,000 in 1964.

Direct-shipping underground iron ore has become much less competitive in the market in recent years. The decrease in demand for this type of ore is reflected in the fact that production of Michigan mines during 1962-63 was 28 percent less than for 1960-61, and almost 40 percent less than the average of the period 1952-61. This has been a prime factor in the decrease in the valuation of iron ore properties.

Lack of market for direct-shipping iron ore was a principal factor in the closing of five underground mines during the biennium. At the end of the period, Michigan had 12 direct-shipping underground mines and one siliceous open pit compared with the 34 direct-shipping underground mines or open pits and five siliceous pits of 10 years ago.

Although the number of mining properties to be valued continues to decline, the changing status of the iron ore industry has created new problems and additional work in the determination of valuations. Not only the active mines but also the idle and undeveloped properties must be continually reviewed in the light of existing and foreseeable conditions.

Iron ore benefication plants using low-grade iron ore are subject to a specific tax in lieu of the general property tax. The tax is determined by the average rate of production and the value of iron ore. The total specific tax on beneficiation operations was $436,639.45 in 1963 and $626,316.16 in 1964.

Loss of production from underground direct-shipping mines is rapidly being offset by production of high grade iron ore pellets from the beneficiation plants. At the end of the biennium the state has four of these operations. With construction of one new plant and expansion of two others during the biennium, annual capacity was more than doubled to about 6,000,000 tons. Production of beneficiated iron ore totaled 7,703,556 tons during the two year period 1962-63, almost double that of 1960-61. During 1963, this high grade ore constituted about 45 percent of Michigan's total iron ore production. In 1954, the first year of beneficiation, it was less than two percent.

When considered in terms of total iron ore production, direct-shipping and beneficiated, Michigan production during 1962-63 was only about four percent less than for 1960-61, and nine percent below the 1952-61 average. Increased beneficiation capacity should reverse this trend during the next biennium.

Production of copper from Michigan's mines and reclamations during 1962-63 increased almost 14 percent over that of 1960-61, and was more than 50 percent above the average for the 1952-61 period. The gain in output was due to increased production from the White Pine Mine where copper is recovered from sulphide ore. The native copper mines continued to decline. Their production in 1963 was at the lowest level since 1874.

Exploration in the copper district resulted in the discovery of a new mine, the Kingston. This property was in development at the end of the biennium. Both surface and underground exploration continue in an effort to discover new ore deposits to permit continuance of the native copper industry. Development of the Southwest Orebody at White Pine was suspended because increased reserves at the White Pine Mine assure sufficient ore to meet needs.

Acceleration of the geologic mapping and iron ore investigations program in the western half of the Northern Peninsula was made possible during the biennium by increased appropriations. This is a cooperative project with the U. S. Geological Survey. Field work continued on the Marquette Range and a new program was instituted in Gogebic County. At the end of the biennium the following work was in progress:

Geologic mapping in the Negaunee-Palmer quadrangles.
Aeromagnetic study of the Marquette district.
Geochemical and glacial investigations in Marquette County and adjacent areas.
Geologic mapping of the Wakefietld NE and Marenisco 7½-minute quadrangles and ground magnetometer survey in the Marenisco and Thayer 7½-minute quadrangles.
Geologic mapping in the Marenisco-Watersmeet area.
Aeromagnetic study of the Gogebic district.

The field work in progress has as its aim the compilation of basic geologic data which will aid in the interpretation of the geology and geologic environment of the region. Areas exist which appear to have potential not only for iron and copper, but also other minerals. However, available data is such that encouragement is lacking for mineral companies to institute exploration programs. With more complete and up-to-date data resulting from the cooperative mapping project, the mineral potential of the area can better be determined.

In accordance with policies of both the United States and Michigan Geological Surveys, data are released for

exploration purposes as soon as the survey of an area is completed. During the biennium, the following reports were released to open file:

Geologic maps of the Marquette and Sands quadrangle.
Geologic and magnetic survey of a part of the Palmer 7½-minute quadrangle.
Aeromagnetic map of parts of Marquette, Dickinson, Baraga, Alger and School-craft counties.
Aeromagnetic map of central Gogebic County.
Aeromagnetic map of the Bergland and part of the White Pine quadrangles.
Aeromagnetic maps of 12 quadrangles in Keweenaw Peninsula (published).

In addition, the following reports are in preparation or in technical review:

Geology and copper deposits in Upper Keweenawan rocks of Michigan.
Geology of the native copper deposits of Michigan.
Geology of the Kelso Junction quadrangle.
Geology and ore deposits of the Iron River-Crystal Falls district.
Geology of the Menominee iron-bearing district.
Geology of the Marquette and Sands quadrangles.
Structure and stratigraphy of Lower and Middle Animikee rocks east of Teal Lake.

Office research continued on the compilation of data to be used in preparation of more adequate maps in areas outside of the presently productive iron and copper districts. Contributions were also made to the Geological Names Committee.

The unit served as inter and intra-departmental geological consultant. It cooperated with the Lands Section in appraising land exchanges involving mineral lands, three of which concerned acquisition of recreational lands for state-owned mineral rights.

Annual reports of exploratory work done on state lands held under copper, iron ore and uranium leases were reviewed and the leased lands were inspected for conformance with lease requirements.

NON-METALLIC MINERAL RESOURCES

The Non-Metallic Unit worked toward its principal objective: to obtain and distribute information relative to the non-metallic resources in the State. Field visits were made to the many mineral producing areas for the study of the various types of minerals produced—limestone, dolomite, sandstone, gypsum, clay, shale, salt, brine, peat, marl, sand and gravel. Quality of the raw material was discussed with the individual mineral operators as were the mining and processing techniques employed—all involved in making the mineral material a marketable product. Information obtained provided the background necessary for proper evaluation and appraisal of rock and mineral deposits located elsewhere in the State. In this way the unit has been able to provide information on the areal distribution of mineral deposits, character and probable thickness of the deposits and the overburden. As a result, this unit was able to provide reliable data on areas of potential mineral resources to those seeking sites for operations.

Several road contractors, through assistance from this office, found new sources of aggregates near points of construction. From information made available on glacial drift and the underlying bedrock, a cement firm is reported to have located a future high-calcium stone reserve in southeastern Michigan. A prominent sand producer located a source of high-silica sand in southeastern Michigan, and a stone deposit in the Saginaw Bay area suitable for bituminous road shoulder and resurfacing use

In conjunction with field visits to the mineral producing areas, rocks and mineral specimens were collected for the making of some 1,000 rocks and mineral sets of 18 specimens each. These were sold to school children, teachers, and rock collectors. Rock specimens representative of various geological formations were also collected in conjunction with field work for reference and use in the Lansing office.

Knowing the value of light-weight aggregate in the construction industry for light-weight block units, precast, tilt-up panels, roofs, and floor slabs, prestressed structural units for bridge overpasses and decks, the Non-Metallic Unit is cooperating with the U. S. Bureau of Mines in investigating shale deposits for that purpose. During spring of 1964, samples of 300 pounds were collected from each of ten shale locations in the Southern Peninsula. Those represented some seven geological formations that are exposed or near the surface in areas near highway or water transportation within easy reach of city markets. Of the samples collected, a 100-pound sample from each of the ten locations was shipped to the Bureau of Mines, Minneapolis, Minnesota for preliminary tests and a 200-pound sample was shipped to the Bureau's laboratory in Norris, Tennessee for expansion tests. Results of the test will be published as a Report Investigations by the U. S. Bureau of Mines and made available to the public during the next biennium. Presently, only one concern in Michigan is producing light-weight aggregate from Michigan natural mineral raw materials while others are needed to meet the increasing demands for this product.

The unit has also cooperated with state highway engineers by supplying geological information on portions of proposed routes for new highways and quarries supplying or having the potentialability of supplying aggregates for their construction.

Determining mineral worth for the Lands Section of State land involved in sale or exchange continues as a regular function of the unit. For example: a proposed state park site in a sand dune area in Van Buren County was examined and recommendations given as to commercial worth of the sand and the cash value of a sand plant operating on the site. In Clinton County, a gravel appraisal involving mapping, test pitting, and gravel volume determinations were made on a state-owned

parcel desired by a gravel operator for future reserves and production. In Osceola County, the case of Big Lake was settled out of court largely through combined work contributed by the Non-Metallic unit and Water unit of the Geological Survey.

Some 550 metallic and non-metallic mineral producers were canvassed for production data; as a result the unit obtained data on quantity and value of the raw mineral material produced, labor, and business conditions, trends, and uses for which the raw material was sold. Completion of the data received showed that the value of Michigan mineral production for 1963 exceeded the 1962 level by $47,900,000 and that of 1961, the best year coverage of the last biennium, by $42,320,00. Iron ore continued to be first in value followed by cement, natural salines, copper, and petroleum. Following is the value of Michigan mineral production by Group Commodities for 1963:

	Value	Percentage
Non-metallic	$269,482,547	55.5
Metallic	155,588,835	32.0
Fuels	60,509,334	12.5
	$485,580,716	100.0

During fiscal 1962 and 1963, two reports covering mineral statistics 1961 and 1962 of two industries were prepared and issued and the report for 1963 was in progress. In addition to statistics on minerals produced during the year, reports included features of interest to students, teachers, and others. These contained maps showing mineral producing areas in the State, charts, and tables, pictures of mineral operations, information on research progress, legislation, publications, and a section on estimated mineral production for the coming year.

Other than supplying basic information on the mineral resources of the state, the Non-Metallic Unit worked on individual mineral commodity reports, geological maps, and the nomenclature of the Cambrian and Ordovician Age of rock formations.

Maintaining inventories on the mineral deposits of the State, identifying rock and mineral specimens sent in by school children, teachers, and citizens of the general public, supplying rock and mineral specimens for classrooms use and exhibits, and answering inquiries on all phases of geology continued to be an important part of the work of the Non-Metallic Unit.

WATER RESOURCES

Concern over water levels in the State is reaching a new high, due to the drouth which has belabored the State for the last four years. Normal precipitation, cumulative departures from normal, and percent over the period August 1, 1960 to July 31, 1964 are as follows:

Weather Bureau Division	Cumulative Normal Precip.	Cumulative Departure from Normal	Cumulative Deficiency
West Upper Division	128.20″	-16.63″	12 %
East Upper Division	126.68	-12.91	10 %
Northwest Lower Division	122.16	- 5.32	4.5%
Northeast Lower Division	116.32	- 9.44	8.1%
West Central Lower Division	125.00	- 8.13	6.5%
Central Lower Division	120.04	- 8.64	7.2%
East Central Lower Division	114.36	-10.62	9.3%
Southwest Lower Division	137.64	-17.39	12.6%
South Central Lower Division	131.68	-30.51	23 %
Southeast Lower Division	122.72	-19.10	15 %

Most inland lakes are low and riparian owners are desperately trying to correct the condition by dredging, blasting to open up springs, and test drilling to find a ground water supply which is not in hydraulic connection with the lake. In two cases in Oakland County, water is being pumped from nearby streams.

Artificial lakes are being developed for residential sites by damming up stream valleys and deepening and widening of tributaries, and using the spoil for filling wet lands for building sites. Water Unit personnel investigate and advise.

Much time is spent with Water Resources Commission and Health Department staffs investigating sites for sewage lagoons for municipal and industrial waste. Many of these depend on seepage for disposal of effluent into the ground water. The effluent from laundromat lagoons contains detergents, nutrients and chlorides. These constitutents are not filtered out, but travel with the ground water only becoming diluted by diffusion. A knowledge of the direction of ground water movement is essential before approval can be given. The practice of disposal into fresh ground water is questionable, because future use of the land is not known.

Personnel of the unit continued to appraise municipal water supplies for the Health Department, well locations for the Highway Department, and acted as owner's representatives on wells drilled for other sections of this Department.

The case of Big Lake, Osceola County was settled in the circuit judge's chambers by compromise. The settlement was made possible by the determination of where the waters edge would have come at the "normal" lake level before shore line alterations took place. This was a truly interdisciplinary project accomplished as the result of the combined efforts of the Water Unit and Non-metallics Unit of the Geological Survey and personnel from the Engineering and Lands Sections.

A co-operative program with the U. S. Geological Survey produced reconnaissance reports of Alger and Menominee counties. Water Resources studies of Van Buren County and the Battle Creek area were completed and reports prepared for printing. A Water Supply Paper on the Kalamazoo area has been approved, and studies are progressing on Branch, Kalamazoo, and Dickinson counties, the tri-county area around Lansing, and the Marquette Iron Range in Marquette County.